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ABSTRACT

This paper reports an attempt to replicate previously published findings on the interrelationship between free-recall performance and selected cognitive abilities. In Experiment I, 300 7th and 12th graders responded to a battery of eight intelligence and memory tests and were then randomly assigned to one of three pre-learning instructional conditions (control, organizational chunking, and rote rehearsal). In Experiment II, 120 3rd and 10th graders were asked to recall items either immediately or following a 30-second delay (the latter presumably fostering conceptual activity). Utilizing a rote-conceptual distinction as potentially relevant in mediating interrelations between abilities and learning, the authors expected that systematic differentiated patterns of recall-ability covariation would emerge as a function of age, practice, and experimental treatment. However, most of the predictions were not confirmed, even those serving to replicate the previous findings. It is argued that such negative results necessitate a closer examination of the underlying theoretical model--specifically, a more thorough consideration of the appropriate treatment conditions and ability markers. (Author)

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THE RELATIONSHIP BETWEEN RECALL PERFORMANCE AND ABILITIES: A SECOND LOOK

REPORT FROM THE PROJECT ON CHILDREN'S LEARNING AND DEVELOPMENT

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Technical Report No. 314

THE RELATIONSHIP BETWEEN RECALL PERFORMANCE AND ABILITIES: A SECOND LOOK

Gisela Labouvie-Vief and Joel R. Levin

Report from the Project on Children's Learning and Development

Wisconsin Research and Development Center for Cognitive Learning
The University of Wisconsin
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Statement of Focus

Individually Guided Education (IGE) is a new comprehensive system of elementary education. The following components of the IGE system are in varying stages of development and implementation: a new organization for instruction and related administrative arrangements; a model of instructional programing for the individual student; and curriculum components in prereading, reading, mathematics, motivation, and environmental education. The development of other curriculum components, of a system for managing instruction by computer, and of instructional strategies is needed to complete the system. Continuing programmatic research is required to provide a sound knowledge base for the components under development and for improved second generation components. Finally, systematic implementation is essential so that the products will function properly in the IGE schools.

The Center plans and carries out the research, development, and implementation components of its IGE program in this sequence: (1) identify the needs and delimit the component problem area; (2) assess the possible constraints—financial resources and availability of staff; (3) formulate general plans and specific procedures for solving the problems; (4) secure and allocate human and material resources to carry out the plans; (5) provide for effective communication among personnel and efficient management of activities and resources; and (6) evaluate the effectiveness of each activity and its contribution to the total program and correct any difficulties through feedback mechanisms and appropriate management techniques.

A self-renewing system of elementary education is projected in each participating elementary school, i.e., one which is less dependent on external sources for direction and is more responsive to the needs of the children attending each particular school. In the IGE schools, Center-developed and other curriculum products compatible with the Center's instructional programing model will lead to higher student achievement and self-direction in learning and in conduct and also to higher morale and job satisfaction among educational personnel. Each developmental product makes its unique contribution to IGE as it is implemented in the schools. The various research components add to the knowledge of Center practitioners, developers, and theorists.

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Abstract

This paper reports an attempt to replicate previously published findings on the interrelationship between free-recall performance and selected cognitive abilities. In Experiment I, 300 7th and 12th graders responded to a battery of eight intelligence and memory tests and were then randomly assigned to one of three pre-learning instructional conditions (control, organizational chunking, and rote rehearsal). In Experiment II, 120 3rd and 10th graders were asked to recall items either immediately or following a 30-second delay (the latter presumably fostering conceptual activity). Utilizing a rote-conceptual distinction as potentially relevant in mediating interrelations between abilities and learning, the authors expected that systematic differentiated patterns of recall-ability covariation would emerge as a function of age, practice, and experimental treatment. However, most of the predictions were not confirmed, even those serving to replicate the previous findings. It is argued that such negative results necessitate a closer examination of the underlying theoretical model--specifically, a more thorough consideration of the appropriate treatment conditions and ability markers.

I
Introduction

Research into intellectual development has for a long time proceeded along two divergent routes. On the one hand, the psychometric tradition has emphasized primarily the identification of broad individual difference variables. On the other hand, researchers in the field of children's learning are usually concerned with manipulating task parameters in order to identify the psychological processes that are involved in efficient or inefficient performance. There has been a gap, however, in the communication between these two approaches (Baltes & Labouvie, 1973; Whiteman, 1964).

Since Cronbach's (1957) emphasis on the need for a rapprochement between these "individual difference" and "task parameter" approaches, research on interactions between aptitude measures and task parameters has enjoyed increased popularity. Such research is of prime importance in attempting to formulate models that frame individual difference variables in terms of the process constructs of contemporary learning theories (Jensen, 1967; Melton, 1967). Unfortunately, however, the empirical research has not fulfilled this promise. Rather, it has proceeded "on the basis of trial and error [Salomon, 1972, p. 327]"--so much so that we are now overwhelmed with a variety of results that are difficult, if not impossible, to render meaningful or even to replicate (Berliner & Cahen, 1973; Cronbach's & Snow, 1969; DiVesta, 1973; Salomon, 1972). Thus, in contrast to the current shotgun approach in which large numbers of aptitude measures are correlated with a minimum of theoretical justification, many authors have concluded that we cannot hope to find a useful conceptual scheme a posteriori unless it is utilized on an a priori basis to generate research. What is needed is hypothesis-oriented, programmatic research in which the selection of individual difference measures and treatments is based on specific hypotheses about their interactions (Berliner & Cahen, 1973; Levin, in press; Salomon, 1972).

One potentially useful lead for the development of a theoretical scheme to organize aptitude-by-treatment interactions is represented by research aimed at demonstrating relationships between learning performance and intellectual abilities (e.g., Dunham, Guilford, & Hoepfner, 1968; Fleishman, 1972; Frederiksen, 1969). In general, the outcome of this research has supported the conclusion that the pattern of abilities related to learning proficiency depends upon specific task conditions, such as treatment condition, task proficiency, etc. This finding is congruent with the assumption that the covariation patterns between learning performance and abilities reflect treatment- and trial-associated changes in the processes underlying learning.

In a previous study using college students as subjects (Labouvie, Frohring, Baltes, & Goulet, 1973), an attempt was made to specify the processes underlying learning by proposing that interactions between ability measures and learning tasks reflect the use of common strategies or skills. Based on the associative-conceptual distinction inherent in many current formulations of developmental learning processes (Goulet, 1973; Jensen, 1971; Kendler & Kendler, 1970), it was expected that the pattern of correlations between abilities and learning effectiveness would reflect the extent to which subjects utilized (or did not utilize) a conceptual strategy. The task selected was free-recall learning, and an attempt was made to manipulate the degree to which subjects would rely on a conceptual strategy, namely subjective organization (Tulving, 1968). It was predicted that under conditions conducive to a high amount of subjective organization, free recall would be closely related to reasoning and general intelligence variables; in contrast, under conditions less conducive to the utilization of organizational strategies, learning would show a closer relation to variables reflecting rote memory.

Since subjective organization typically increases over trials and is more likely to be present under delayed than under immediate recall (Atkinson & Shiffrin, 1968; Shuell, 1969), practice and timing of recall were used in the Labouvie et al. (1973) study to influence conceptual strategies which mediate learning-ability relationships. Results showed highly meaningful changes in correlational patterns as a function of practice: a strong initial contribution of memory abilities decreased progressively over trials, while the contribution of general intelligence factors showed a corresponding increase. Moreover, this pattern was systematically affected by timing of recall: general intelligence dimensions were most predictive under delayed recall; rote memory variables predicted best under immediate recall.

Due to the systematic nature of these observations (task x ability x trial interactions), it appeared desirable to extend it into a developmental framework. Since age is another variable systematically affecting subjective organization in free recall (Jensen & Frederiksen, 1970; Laurence, 1966; Rosner, 1971), similar changes in learning-ability covariation patterns might be expected as a function of age. Indeed, Glasman (1968) reports data in agreement with such an interpretation. In kindergarten, subjects' mental age and free-recall performance were uncorrelated, whereas substantial correlations were obtained among fifth graders.

II
Experiment I

In order to test the assumption that covariations between learning and abilities are mediated by basic underlying processes or strategies, the present study utilized both age and pre-learning instructions to influence the degree of subjective organization in free recall. While it was expected that in general older subjects would demonstrate a more strategic approach to free-recall learning, these age differences were expected to interact with the type of pre-learning instructions given by the experimenter. Specifically, it was predicted that if subjects were instructed to form mediational links or chunks between items (Bower, 1970; Rosner, 1971), increased emphasis on conceptual activity would result. This in turn would be reflected by an increased relationship between free recall and reasoning or general intelligence variables. Conversely, if subjects were provided with a strategy that interfered with their chunking activity (thereby rendering the learning task more rote-like), a corresponding decrease in the contribution of reasoning and intelligence variables and an increase in the contribution of memory variables would be observed.

Subjects

Teen-age students were used as subjects in this study because a review of the literature suggested that the kind of mediational activity of interest in this task may undergo significant age-related changes during adolescence (Laurence, 1966; Rosner, 1971). A stratified (grade, sex) sample of 300 subjects was obtained from a rural Pennsylvania high school, with 150 subjects from grade 7 (mean age: 12 years, 11 months) and 150 subjects from grade 12 (mean age: 17 years, 9 months). Equal numbers of male and female students were drawn randomly from the class lists and assigned to one of the three instructional conditions. Thus, a total of 50 subjects (25 males, 25 females) was tested at each level of age and instruction.

Recall Task

The task consisted of the free recall of 22 unrelated familiar objects presented pictorially. Each picture was presented on a screen for two seconds with interstimulus intervals of about one second. The presentation of all 22 pictures constituted one study trial. The experimenter indicated verbally the name of each stimulus upon visual presentation in order to reduce labeling errors. Twelve study trials were provided. On each trial the pictures were presented in a different random order (constant across subjects), with the restrictions that each picture appear in each serial position just once and that each picture be preceded or followed by any other picture just once. Following each study trial, subjects were allowed 90 seconds of recall time in which they were to write down, in any order, the names of all the pictures they remembered.

Instructional Conditions

Three instructional conditions were included: (1) standard free-recall instructions, (2) chunking instructions (presumably enhancing conceptual activity), and (3) rote rehearsal instructions (presumably interfering with conceptual activity, cf. Bower, 1972).

Under standard instructions, the general task requisites were described to all subjects prior to Trial 1. Under chunking instructions, subjects were told to make up ways in which the pictures "go together." An example using two items not contained in the list was provided (match-candle: The match lights the candle). Subjects then were asked to provide

mediational links for any combinations of two or three out of a sample set of three other stimuli not contained in the list (rabbit-fence-boat). Under rehearsal instructions, subjects were instructed to repeat each item twice to themselves as it was presented (thereby filling the rehearsal interval with nonmediational activity). This procedure was demonstrated with the sample pair, and subjects then were asked to practice it with the sample triad.

Memory and Intelligence Variables

All ability tests were selected on the basis of previous factor analytic work aimed at structuring the universe of both general intelligence and memory abilities. Thurstone and Thurstone's (1962) Primary Mental Abilities (PMA) test was chosen to mark the intelligence domain. The PMA includes four factors: verbal meaning, number facility, reasoning, and space.

Tests of memory abilities were obtained from the French, Ekstrom, and Price (1963) Kit of Reference Tests for Cognitive Factors and from a factor analytic study of memory abilities by Kelley (1964). According to Kelly, each of the four tests measures a different memory factor. Object-Number is supposedly a test of "associative" memory and requires the learning of word-number paired associates. Auditory Number Span, a test consisting of number series of varying lengths, is assumed to load "span" memory. Recognition, presumably a test of "rote" memory, consists of the presentation of a list of 25 unrelated words, followed by a presentation of a second list of 50 words; subjects are required to specify for each word of the second list whether or not it was contained in the first. Finally, Memory for Words is a paired-associates task involving pairs of associatively related words (e.g., nation-state); this test supposedly measures "meaningful" memory.

Procedure

Subjects were tested in two sessions, the first taking approximately 90 minutes and the second about 40 minutes. In order to minimize subject attrition, both sessions were held on the same day. In the first session, the battery of memory and intelligence tests was administered to groups ranging in size from 40 to 50 subjects. Subsequently, students were asked to return to one of three sessions in which the free-recall task was given under one of the three instructional conditions. Assignment of subjects to instructional conditions, as well as the order in which instructional conditions were administered, was previously determined on a random basis. In each free-recall session, subjects were tested in groups of about 15.

Data Analysis

Recall scores for each subject were obtained by computing the number of correctly recalled stimuli at each of the 12 trials. These scores were subsequently collapsed into four blocks of three trials. Each subject's four block-scores constituted the recall data for the final analysis.

Analysis of the data proceeded in two steps. The first step attempted a descriptive evaluation of recall-ability covariation patterns, and it closely corresponded to the pattern followed in the Labouvie et al. (1973) study. First, a 12 x 12 correlation matrix was computed, with the four PMA subtests, the four memory tests, and the four recall scores entered as variables. Changes in trial-to-trial covariation patterns were then examined by computing sets of multiple correlation coefficients between either intelligence or memory variables as predictors and each of the four trial blocks as the criterion variable. These multiple correlations were computed separately for each of the grade-instructions groups.

In order to provide an inferential test for trial- and treatment-related changes in the association between marker tests and recall, additional analyses were conducted. In these analyses subjects were divided into "high" and "low" groups for the memory markers and "high" and "low" groups for the intelligence markers according to whether they were above or below the median for their age group on the particular marker. Since the correlations among the four PMA variables proved to be very high (as did those among the four memory variables), it was decided to simplify these analyses by concentrating on just one index for the PMA tests and one for the memory tests. Accordingly, the first principal component from each 4 x 4 correlation matrix of the two marker sets (PMA, memory) was extracted. (The correlation matrices from which the components were extracted were based on the total sample of 300 subjects.) Then individual factor scores on each of these components were computed. Two component scores thus were computed per subject, one for the PMA tests, the other for the memory tests. These two component scores were the classification variables used in all subsequent analyses.

Utilizing each high-low classification scheme (intelligence and memory), separate analyses of variance were conducted in which the principal factors were Grade (7th and 12th), Instructions (standard, chunking, and rehearsal), and Classification (high and low). The trial-block recall scores comprised four dependent variables in a multivariate repeated measures framework. Linear combinations of these four variables were created to identify linear and curvilinear effects associated with practice. With classification groups nested in grades and instruction, the replication of Labouvie et al. (1973) would have (a) the high and low intelligence groups becoming increasingly divergent with free-recall trial blocks, and (b) the high and low memory groups becoming increasingly convergent. In addition, the present hypotheses would have these effects augmented or diminished by particular grade levels and instructional conditions, in the manner previously described.

Results

Marker-Recall Covariation Patterns

The multiple correlations between each marker set and the trial-block scores are presented in Table 1. Note when examining Table 1 that, according to present hypotheses, the highest correlations between PMA and recall (as well as the lowest memory-recall correlations) should have been obtained in 12th grade under chunking instructions and in late trial blocks. The highest memory-recall and lowest PMA-recall correlations, on the other hand, should have been obtained in the 7th grade rehearsal group at the beginning of learning. However, inspection of Table 1 reveals little dramatic difference related to age, instructions, or practice. With few exceptions (to be noted shortly),

TABLE 1

Summary of Multiple Correlation Analyses (Experiment I)

Condition	Trial			
	1-3	4-6	7-9	10-12
PMA				
Grade 7, Standard	479	535*	611**	525*
Grade 7, Chunking	556*	541*	600**	597**
Grade 7, Rehearsal	434	527*	443	486
Grade 12, Standard	466	467	469	421
Grade 12, Chunking	528*	391	330	369
Grade 12, Rehearsal	596**	568*	542*	491
Memory				
Grade 7, Standard	499	552*	605**	590**
Grade 7, Chunking	621**	565*	541*	543*
Grade 7, Rehearsal	557*	584*	534*	574**
Grade 12, Standard	585**	558*	573*	645**
Grade 12, Chunking	444	504	514	446
Grade 12, Rehearsal	409	295	331	220

* $p < .05$

** $p < .01$

Note: Cell entries are multiple correlation coefficients computed between either PMA or Memory markers (predictor variables) and a specified trial block (criterion variable). Decimals are omitted.

most of the correlations are uniformly high and unaffected by trials.

Analysis of Variance by Marker Classifications

Analyses of the free-recall data based on PMA and memory marker classifications produced two major findings which supplement the multiple correlational results. First, of the twelve statistical tests in which trial-related changes of high and low marker classifications were compared (i.e., within two grades and three instructional conditions for PMA and memory classifications), only one was significant in the predicted direction, namely that for the PMA component within the 7th grade standard condition ($p < .005$). As may be seen in Table 2, the data are in accordance with the predictions derived from the Labouvie et al. (1973) study: when general intelligence variables are considered, differences between high- and low-ability subjects increase with trials, thereby paralleling the general increase in PMA-recall correlations in this group (cf. Table 1).

This finding is, however, restricted to the PMA classifications of 7th graders in the standard condition (all other p's $> .05$). Thus, it must be concluded that neither the expected opposite pattern based on memory classifications, nor the expected contributory effects of age and instructional conditions, materialized in the present experiment.

The latter issue may be resolved somewhat, if the second major finding is considered: namely, that the three instructional conditions did <u>not</u> differentiate among subjects' performance in terms of either overall recall or trial-related changes. This was true in both the 7th and 12th grade samples (all p's $> .05$). Thus, it might be argued that the hypothesis concerned with the effect of instructions was not validly tested here, since no significant effects due to this variable were obtained.

TABLE 2

Free-Recall Block Scores of Ss with High and Low PMA Components in the Seventh Grade Standard Condition

	Trial Block			
	1-3	4-6	7-9	10-12
High	11.50	14.95	16.13	17.13
Low	10.32	12.76	13.54	14.52
Difference	1.18	2.19	2.59	2.61

III
Experiment II

The results of Experiment I were at best only weakly supportive of the position developed in this paper, since no differentiated instructional and age effects occurred. In part, this lack may be because the selection of the instructional conditions and age groups was less than optimal. In Experiment II, therefore, an attempt was made to maximize treatment effects by selecting more disparate age levels.

In accordance with Labouvie et al. (1973), it was assumed that the insertion of a delay between stimulus presentation and recall would result in a greater degree of subjective organization (Atkinson & Shiffrin, 1968; Postman & Phillips, 1965). It was therefore predicted in Experiment II that the correlation between free recall and reasoning would increase with increasing age and would be stronger under delayed than under immediate recall. Again, it was assumed that complementary memory-recall coveriation changes would be found in the opposite direction (i.e., that memory-recall correlations would be strongest under immediate recall and/or in the younger age group). Due to the absence of trial-related changes in Experiment I, no predictions relating to trials were made.

Subjects

A total of 120 subjects was sampled from grades 3 (N=60; mean age: 8 years, 10 months) and 10 (N=60; mean age: 16 years, 7 months) from a rural Wisconsin school system. Equal numbers of male and female students were randomly selected from the class lists and assigned to one of two delay conditions.

Recall Task

The free-recall task was similar to that utilized in Experiment I. In each study trial, 20 unrelated familiar objects were presented pictorially on a screen, and during the first study trial the experimenter named each stimulus as it appeared. There were study trials. On each trial, subjects were presented with a new random order (constant across subjects) of the pictures. Following each study trial there was a 90-second recall period during which subjects named in any order all the stimuli they could remember.

For half of the subjects at each grade level (delay), each study trial was followed by a 30-second delay period during which subjects attended to an interpolated activity (letter cancellation). The remaining subjects recalled immediately upon termination of each study trial (no delay). In the latter condition, however, the interpolated task was performed following recall in order to equalize intertrial intervals.

Intelligence and Memory Tests

Since high intercorrelations between all PMA components were found in Experiment I, it was decided to use just one test of intelligence. Raven's Progressive Matrices was chosen because it is applicable to discrepant age groups.

It was similarly decided to restrict the sample of memory tests to a digit span test, since this test, according to Jensen (1971), is best indicative of rote (or Level I) learning. The test was patterned after one developed by Jensen (cf. Jensen & Rohwer, 1970) and

utilized digit series administered in order of increasing difficulty. Three such series were presented.

Procedure

As in Experiment I, subjects were tested in two sessions held on one day. In the first session, groups of ten students were administered the Raven and digit span tests. Subsequently, students returned individually for the free-recall task.

Results

The data were analyzed following the steps outlined in Experiment I, although the analysis was simplified since only one marker test apiece was utilized to tap the intelligence and memory domains. The correlational results are presented in Table 3. Note that for the correlations between free-recall and Raven performance, there appears to be treatment-related differentiation. However, the pattern is in the opposite direction to that predicted, in that the correlations are

TABLE 3

Trial-to-Trial Correlations Between Marker Tests and Free Recall (Experiment II)

Condition	Trial				
	1	2	3	4	5
Raven					
Grade 3, No Delay	368*	196	385*	481**	196
Grade 3, Delay	140	-211	-053	-202	-136
Grade 10, No Delay	268	632**	242	357	190
Grade 10, Delay	206	-145	-093	-038	-119
Digit Span					
Grade 3, No Delay	143	015	-119	-037	028
Grade 3, Delay	-358	-086	068	-134	-057
Grade 10, No Delay	275	327	138	079	169
Grade 10, Delay	143	-122	-189	-100	007

* $p < .05$

** $p < .01$

Note: Decimals are omitted.

consistently higher under no delay than under delay. In the nested analyses of variance of the free-recall scores, the third-grade no delay sample was the only one in which a significant difference between high and low scorers on the Raven was detected ($p < .05$, one-tailed). Moreover, interpretation of these results is complicated by the lack of a significant effect of delay in either grade (both F's < 1), indicating that this manipulation did not accomplish what was intended--as was true with the strategy manipulation in Experiment I.

Although the analyses of the recall scores produced the expected grade and trial effects (both p's < .001), nothing systematic is revealed in the marker-recall correlation patterns. Moreover, as in Experiment I, findings based on the Raven classification are not supplemented by complementary (reversed) correlational patterns between digit span and recall. Thus, the hypotheses fail to be supported by the present data.

IV
Discussion

In general, the present findings do not replicate those previously reported by Labouvie et al. (1973). In the study by Labouvie et al., the experimental demonstration of differentiated learning-ability interrelations might prove useful in cross-mapping processes common to learning and ability test performance. Utilizing the rote-conceptual distinction as one potentially relevant in mediating cross-domain linkages, Labouvie et al. postulated and demonstrated treatment- and trial-related shifts in the respective contributions of memory and general intelligence to free-recall learning. The present experiments, however, did not produce shifts that were as systematic or meaningful as those previously obtained. Thus, upon closer examination it appears necessary to temper the enthusiasm expressed in the earlier study; the sought-after effects may be more elusive than was originally conceived.

One way to deal with the present failure to replicate the earlier findings would be to flatly reject this line of research as one likely to be unproductive--an argument familiar to those who have assessed the current state of the art (Berliner & Cahen, 1973; Cronbach & Snow, 1969; Salomon, 1972). We have elected, however, to use our experience to offer some positive suggestions for those attacking similar problems in the future. In particular, we believe that it is not so much the approach that needs improvement, but rather the researcher's interpretation and implementation of the approach.

According to Jensen (1967), a successful linkage between abilities and learning performance ultimately requires the conceptualization of a universe of learning performances, or "phenotypes"--defined by variations in task characteristics, treatment parameters, stages of acquisition, etc.--and the structuring of this universe in terms of "genotypes," or sets of pervasive, basic processes. In line with this reasoning, the present research utilized a number of task variations that were hypothesized to tap differential "genotypes" and, therefore, to produce predictable covariation patterns with selected abilities. As applied to the present experiments, then, such an analysis suggests that the particular selection of ability markers and/or treatment conditions used may have been less than optimal.

Concerning the treatment conditions, it was previously noted that in neither experiment did the manipulations (instructional strategies and timing of recall) affect the total amount recalled. In retrospect, the reason for this appears understandable. To start with, the chunking strategy utilized in the first experiment may not have been appropriate, despite significant results yielded from a comparable strategy in previous research (cf. Rosner, 1971). With chunking, subjects were instructed to form mediational links between any items, but the strategy was demonstrated with item dyads and triads only. However, as is true in serial learning (cf. Jensen & Rohwer, 1970; Levin, 1970), it seems reasonable that an effective strategy for free recall is one that integrates several list items, not just pairs or triplets. For successful free recall, the subject must get from one item "chunk" to the next, and the fewer the number of large-item chunks, the better (see Bower, Lesgold, & Tieman, 1969).

Similar considerations of method hold for the second experiment. Although on the basis of the Labouvie et al. (1973) results, it had been expected that subjects' dependence on short-term processing strategies would increase in the immediate recall condition, it is likely that this occurred in the present delayed recall condition as well as (or instead of) in the immediate recall condition. Specifi-

cally, an interpolated activity of the kind utilized here may have prevented subjects from processing the free-recall stimuli in any conceptual way--quite the opposite of what it was designed to do. Thus, the potential benefits of conceptual activity in the delay condition may have been counteracted by the letter cancellation task, a hypothesis that is conducive to subsequent verification by obtaining delayed performance following an unfilled interval in which Ss are encouraged to think back on the preceding stimuli.

It appears, then, that the present experimental manipulations were not successful in inducing a high degree of mediational homogeneity. One major suggestion following from the present research is the use of treatment conditions that have more dramatic and predictable effects on mediational strategies. In fact, the authors, applying this line of reasoning, have since produced more meaningful patterns of interrelations between abilities (in particular, reasoning) and associative learning.

A second reason that the obtained patterns are difficult to interpret is that the ability markers selected for the study may have only superficially tapped the critical underlying processes. Note that it had been expected that the markers would tap two classes of distinct (and presumably independent) processes; reasoning and short-term memory (see Jensen, 1970). This expectation, however, was not borne out by the present data. In Experiment I, for example, the memory and reasoning variables were highly related (the cross-correlations between PMA and memory tests achieved values as high as .66, whereas in the Labouvie et al. [1973] study, none of the corresponding cross-domain correlations exceeded .20). This would suggest that Jensen's Level 1--Level 2 distinction, which was adopted in this study, does not always yield truly independent process components. In this regard, it might be argued that our finding of differentiated covariation patterns when comparing PMA- or Raven-recall and Memory- or Digit Span-recall correlations somewhat contradicts this line of reasoning. That is, the pattern of statistically significant results did differ from one marker class to the other (i.e., some statistical differences were revealed with PMA and Raven but not with Memory and Digit Span). However, the descriptive data produced by each marker class were generally in the same direction, as may be seen most clearly in Table 1.

Another observation would similarly suggest that the linkage between the ability markers and the processes underlying the learning tasks is of a different nature than was hypothesized. That is, of the design variables used in the present experiment, age and trials are known to account for most of the individual differences variance (see, for example, Laurence, 1966; Rosner, 1971; Shuell, 1969). These are also the design variables that demonstrated the most dramatic effect on recall performance. Yet neither age- nor trial-related changes in recall were accompanied by any systematic changes in recall-ability covariation pattern. Thus, in contrast to the Labouvie et al. (1973) study, it must be concluded that whatever processes underlie trial- and age-related changes in free recall, they were not sensitively assessed by the markers included here.

In a more positive vein, the stronger relationship between reasoning and recall than between memory and recall obtained in Experiment II is surely at variance with positions that hold that many forms of learning (especially those of the laboratory variety) are essentially "rote" in nature. The stimuli utilized in the present study (unrelated and presented randomly) would not, on the surface, appear to elicit any large amount of conceptual-organizational activity, especially in children as young as 3rd graders. Yet it is precisely these children who exhibit reliable reasoning-recall relationships (cf. Table 3 and the corresponding analysis of variance of Experiment II). With such data one would have to question whether a learning task of this kind--even when administered to elementary school children--is really one that relies, to any considerable degree, on "rote" processes (see also Rohwer & Levin, 1971).

The statement above is further substantiated by the rather consistent failure of the Digit Span test to be predictive of free-recall learning--both for the Labouvie et al. (1973) study and for Experiment II of the present research. Indeed, in both, slight but consistent negative correlations were observed. In Experiment I of this study, the same is true, although the finding is obscured because the multiple correlations consist of a linear combination of four memory tests. Thus, again, it appears that a rote-conceptual distinction may not be the most meaningful way of conceptualizing basic genotype processes.

In this context, it is interesting to note that the same criticism has recently been raised by Das (1973) who argues that a more theoretically and methodologically valid distinction might be whether a particular task requires predominantly sequential or parallel information processing. It is Das' contention that the associative-conceptual distinction is

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one of limited value, since different memory tests do not always load on the same factors in factor analytic research, whereas memory and reasoning tests often do.

In conclusion, the present data underscore the contention that theory in the area of learning-ability interrelations is still in its infancy. Certainly no definitive conclusions are warranted on the basis of the present research. However, in line with Berliner and Cahen (1973), we would emphasize that researchers in this area must be sensitive to theoretical leads from many sources and must be willing to continue to conduct the necessary fine-grained analyses of learning processes and intellectual abilities in an attempt to cross-link the two.

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